instruction manual

"MA" HIGH CURRENT
NOBATRONS

Sorensen

SORENSEN
A Unit of Raytheon
Richards Avenue, South Norwalk, Connecticut

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SORENSEN/A UNIT OF RAYTHEON, Richards Ave., So. Norwalk, Connecticut
SB14-2096C
6/63

GENERAL INFORMATION

WARRANTY

SORENSEN/A Unit of Raytheon Company, warrants each instrument it manufactures to be free from defects in material and workmanship. The company's obligation under this warranty is limited to servicing the instrument and replacing defective parts*, when the instrument is returned to the factory with transportation charges prepaid. This warranty is effective for one year after delivery of the instrument to the original purchaser. Defects caused by improper operating conditions, misuse, negligence, or the alteration or removal of the nameplate, will void the warranty. SORENSEN shall in no circumstance be liable for any direct or consequential loss or damage of any nature resulting from the malfunction of the instrument. This warranty is effective in lieu of any or all other obligations or liabilities on the part of SORENSEN/A Unit of Raytheon Company, its agents, or representatives.

SERVICE INFORMATION

Questions concerned with the operation, repair, or servicing of this instrument should be directed to the nearest Sorensen representative (a list is included with this manual) or to the Service Department., Sorensen/A Unit of Raytheon Company, Richards Avenue, South Norwalk, Connecticut. *Include the model number and serial number,* in any correspondence concerning this instrument.

SHIPPING DAMAGE

It is possible for equipment to be damaged in shipment. Therefore, it is imperative that the instrument be tested and inspected as soon as it is received. If the instrument shows signs of damage, follow the instructions on the DAMAGE and/or Loss in Shipment form enclosed with the unit and notify the carrier immediately. The carrier's claim agent will then prepare a report of damage and, after you have forwarded this to the Sorensen Service Department, you will be advised as to the action necessary to have the instrument repaired or replaced.

RETURNS TO THE FACTORY

Should it be necessary to return an instrument to the factory for repair, please contact the Sorensen Service Department for authorization to make shipment.

DO NOT RETURN THE UNIT FOR REPAIR WITHOUT THIS AUTHORIZATION.

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* The warranty excludes special purpose tubes, which carry their own manufacturer's warrantees, and fuses.

II. SPECIFICATIONS

The MA High Current Nobatron is a tubeless high current, DC, power supply designed to provide a continuously adjustable well-regulated output over certain voltage ranges. The MA High Current Nobatron is designed to permit sensing at the load point so as to compensate for the voltage drop in the leads to the load.

MODEL		MA12-200	MA12-500	MA28-125	MA28-250	MA28-500
INPUT POWER AC	Voltage	208, 230 or 460 volts, 3 Phase				
	Frequency	60 Cycles				
	Current	18A	40A	22A	44A	88A
OUTPUT POWER DC	Voltage	12VDC		28VDC		
	Current	0-200A	0-500A	0-125A	0-250A	0-500A
Extended Voltage Range *		9-18 VDC		18-36 VDC		
Regulation * Accuracy	Line	±0.2%		± 0.2%		
	Load	±0.5%		±0.2%		
Ripple (Maximum)		1% RMS at Nominal Output Voltage				
Response Time		0.1 second (For 10% line change or 50% load change)				
Ambient Temperature *		15°C (59°F) to 35°C (95°F)				
Dimensions (inches)	Width	19 1/8	25 5/8	19	25 1/4	25 1/4
	Height	21 1/16	36 1/8	21 1/4	34	42
	Depth	15 7/8	22 7/8	15	23	23
Weight (Net)		225 Lbs.	500 Lbs.	225 Lbs.	500 Lbs.	600 Lbs.
Input Terminal Board		Rear	Side	Rear	Side	Side
Output Terminal Board		Rear	Side	Rear	Side	Side
Protective Devices	Input	Input Fuse **				
	Output	Output Fuse		Klixon	Output Fuse	
		Thermostat & relay for over-temperature control				
Meters		Voltmeter and Ammeter (Standard Equipment)				

* See specification notes on the following page.

** Protects transformers T5, T6 and the blower.

SPECIFICATIONS-SPECIAL NOTES

REGULATION ACCURACY

a. 28VDC Models

The regulation accuracy for line changes is defined as ±0. 2% against a 10% line change at 28VDC and a fixed load current. The regulation accuracy for load changes is defined as ±0. 2% against load changes from no load current to full current at 28VDC output and a fixed input line voltage. Note that the regulation accuracy applies to line or load separately. If line and load are both changed, the total regulation accuracy becomes ±0. 4% maximum. However, a typical unit will have ±0. 1% regulation at 28VDC for any combination of a 10% line change and a 50% load current change.

b. 12VDC Models

±0. 2% regulation accuracy for line changes
±0. 5% regulation accuracy for load changes
±0. 25% regulation accuracy for combined change of 50% load and 10% line.

RESPONSE TIME

Response time is stated as 0. 1 second for a 10% line change or a 50% load change. Response time is defined as the time for the output of the Nobatron to effect a 63% recovery from the maximum deviated value.

AMBIENT TEMPERATURE RANGE

If operation above 35°C (95°F) is attempted, the life of various components may be reduced. In some cases, operation at reduced loads is possible at higher or lower ambients. This is at the discretion and responsibility of the user.

Note: Below 15°C (59°F) a higher initial ripple may be noticed. This will decrease, however, as the instrument warms up, but may still be above 1% RMS at these low ambients.

After allowing thirty minutes for warm-up, drift at a fixed ambient should not be more than 0. 5% for any 24-hour period.

OVERCURRENT PROTECTION

These instruments are equipped with overcurrent devices that protect them from short circuit failure. The Models MA12-200, MA12-500, MA28-250 and MA28-500 employ a fuse for this purpose. The Model MA28-125 employs a Klixon circuit breaker.

EXTENDED RANGE

Extended range operating curves are on pages 15 & 16.

III. INSTALLATION AND OPERATION

Models MA12-200 and MA28-125 may be supplied as self-contained units suitable for bench top operation, or equipped with side brackets for relay rack installation. A change from bench top to rack mounting or vice-versa can be easily accomplished. To purchase the parts needed for such a change, contact our local representative or our Service Department.

Models MA12-500, MA28-250 and MA28-500 are supplied as self-contained floor models. Castors are optional but can be supplied with both models.

INPUT

On Models MA12-200 and MA28-125 the input power is connected to the terminal board located at the inside rear of the unit. It is necessary to remove the rear cover to make the connections and also to carry the input lines through the grommet hole provided in the rear cover.

The input current for each model is listed under Specifications, Section II. The proper wire size for the input lines should be selected after consulting the local wiring codes on the subject.

These instruments are not supplied with an input line ON-OFF switch, therefore, an external safety switch or magnetic circuit breaker should be added by the user.

Models MA12-500, MA28-250 may be supplied with or without an input contactor. This contactor is located on the side of the unit and input power is connected directly to contactor. On models supplied without the contactor input power connections are made to the input terminal board located on the side of the unit.

IMPORTANT: These power supplies are adjusted before shipment to accept an input line of 208 volts ±10%. In the event it is desired to connect the unit to 230 volts input, please refer to the Supplementary Service Information Sheet included with this manual as follows:

A14-4442 for MA12-500, MA28-250 and MA28-500
A14-4443 for MA28-125 and MA12-200

The terminal marked "G" at the input terminals is connected to the chassis and should be connected to the electrical system ground by a wire of the same size as the other input lines.

COOLING

A blower is used to provide forced air cooling. CARE SHOULD BE TAKEN TO INSURE THAT THE AIR FLOW IS NOT RESTRICTED as excessive heat would cause serious damage to various components, particularly the silicon rectifiers.

IMPORTANT: SEE INSTRUCTIONS UNDER MAINTENANCE PAGE 11 FOR CLEANING THE AIR FILTER AND LUBRICATING THE BLOWER MOTOR.

OUTPUT

Models MA12-200 and MA28-125
The output power connections should be made through the grommets on the left rear side of the unit to the terminal board located within the unit on that side. The connections should be made to the two large screw-type lugs on the phenolic terminal board. Number 4 wire size is recommended for the output cable. Neither output terminal is connected to ground; however either output may be grounded.

Models MA12-500, MA28-250 and MA28-500
The output power connections should be made to the output terminal board located on the side of the unit. Number 00 size wire is recommended for the model MA28-250, and number 000 size wire recommended for the model MA12-500 and MA28-500.

CONTROLS

Output Voltage Adjustment: The output voltage is continuously adjustable between 9 and 18VDC for 12 volt units, and 18-36 VDC on 28 volt units. These adjustments are made by means of a voltage control located on the front panel.

PROTECTIVE DEVICES

Input Fuse
The fuse located on the front panel protects the blower and the auxiliary power supply.

Thermal Switch
In the event of overheating caused by blower failure or restriction of air flow, the thermal circuit breakers S1 or S2 will open the relay K1. This relay in turn will cause the output voltage to drop to a safe value. Breakers S1 and S2 reset automatically.

Overcurrent Protection
Some models employ a thermal circuit breaker (manual reset) which is located on the front panel. Other models employ a fuse located within the unit. Refer to the schematic diagram for details on the overcurrent protection employed in this unit.

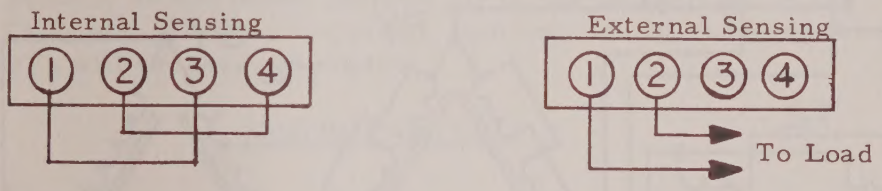
REMOTE SENSING

A useful feature of these instruments is external sensing; that is, sensing of the output voltage at a point quite remote from the unit.

The deterioration of regulation under remote sensing conditions is about 0.1% for every 0.1 ohm of resistance in the sensing leads.

On the models MA12-200 and MA28-125 the sensing is on a terminal board located within the unit on the upper left side when looking from the rear. The arrangement of jumpers for internal and external sensing is shown below.

On the Models MA12-500, MA28-250 and MA28-500 the sensing connections are made at the input-output terminal board.



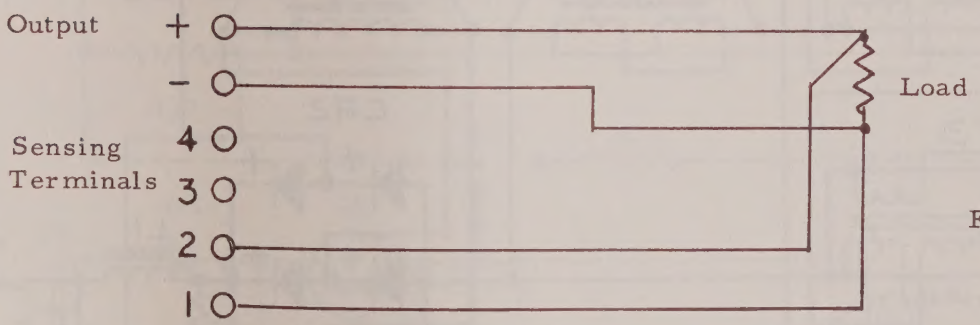


Figure 1

Typical external sensing arrangement

IV. PRINCIPLE OF OPERATION

The operation of the MA High Current Nobatron can best be understood by referring to the schematic diagram included with this manual.

The MA High Current Nobatron consists of a power circuit together with a transistorized control circuit.

POWER CIRCUIT

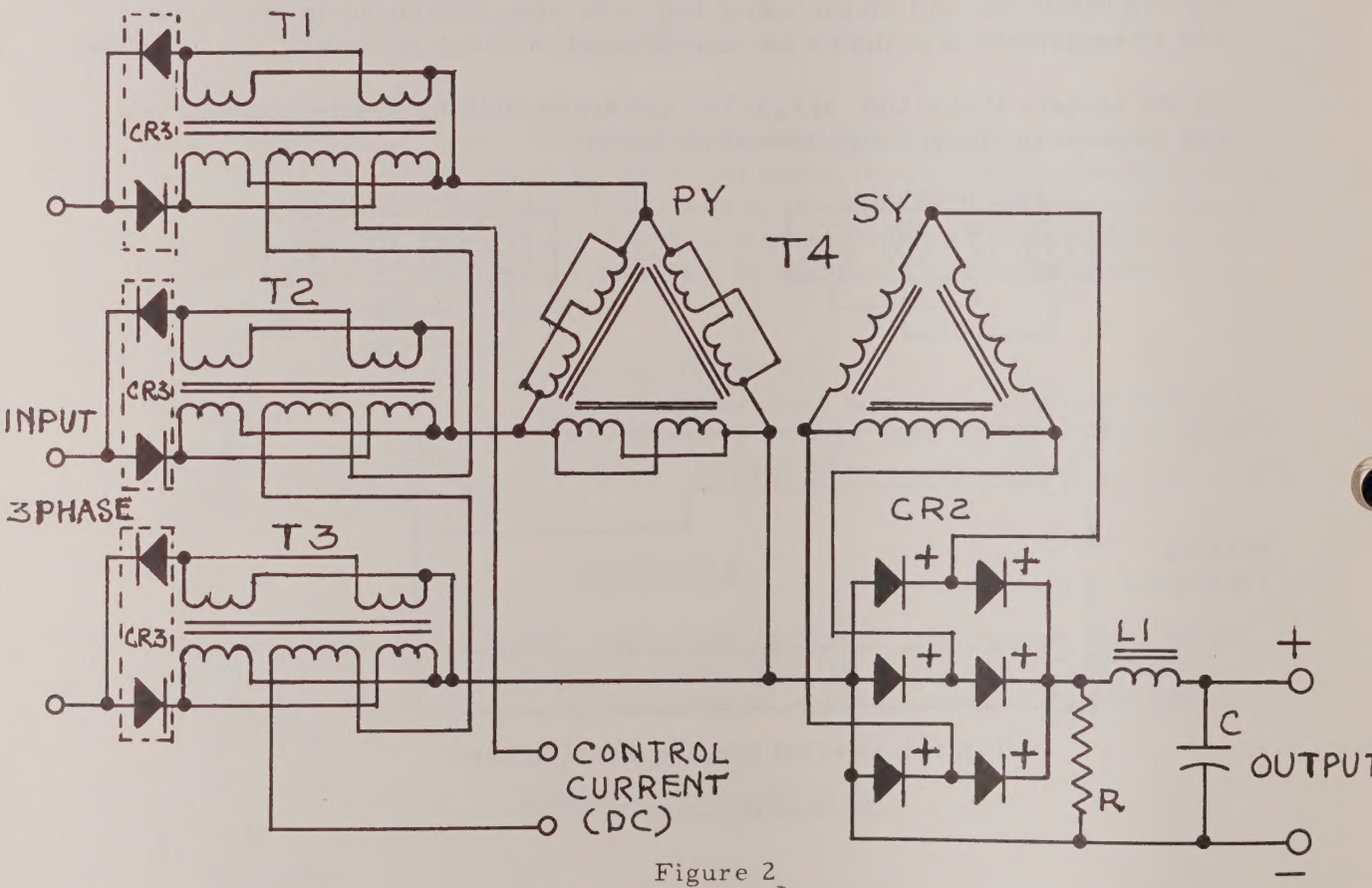


Figure 2

T1, 2 & 3	Self-Saturating Magnetic Amplifiers
T4	Rectifier Input Transformer
CR2	Power Rectifier
CR3	Rectifier (Magnetic Amplifier)
L1	DC Filter Choke
C	DC Filter Capacitors
R	Bleeder

The power circuit consists of a self saturating magnetic amplifier, delta transformer, rectifier and filter. See figure 2.

A detailed explanation of the theory of the magnetic amplifier is beyond the scope of this manual. In simple terms, however, the AC coils on the reactors may be considered to act as "gates" which open at some time during the half-cycle in which the rectifiers CR3 allow conduction. Until the gate opens, no current flows. After the gate opens, current flows and is restricted only by the impedance of the load circuit. The average current, and hence the voltage, is controlled by the fraction of the half-cycle period that the gate is open. For example if the input voltage is reduced, the current flow during the conduction period will be reduced. Therefore, the gate must be opened earlier to maintain the same output voltage.

Opening the gate is controlled by the current in the DC windings of the magnetic amplifiers, T1, T2 and T3. Adding control ampere turns with the same polarity as the power ampere turns, as determined by the rectifier CR3, will increase the output, and conversely reducing the control ampere turns will decrease the output.

CONTROL CIRCUIT

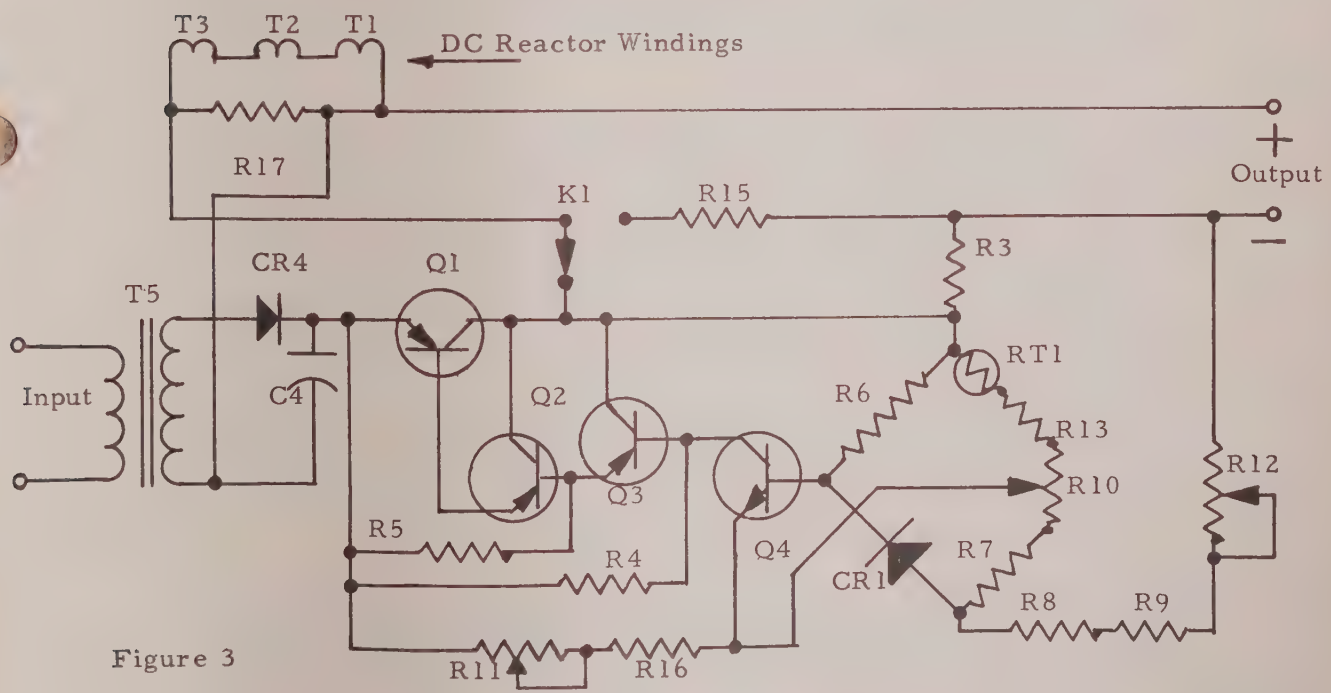


Figure 3

T5 Control Power Transformer
C4 - Filter Capacitor
CR4- Control Power Rectifier
Q1- Series Passing Transistor
Q2-4 Amplifiers
CR1- Reference Diode
R3- Bleeder
R4, 5-Bias Resistors for Q4 & Q5
R6, 7, 13 - Bridge Resistors
R8, 9 - Voltage Dividers
R10 - Reference Centering
R11, 16 - Line Compensation
R12 - Output Voltage Adjust
RT1 - Temperature Compensation
R17 - Anti Surge
K1 - Relay (In Operating Position)

The Control Circuit is a "Power Reference" consisting of a series transistor voltage regulator. The output of the instrument is compared directly to the reference, through the control windings of the magnetic amplifiers, T1, T2 & T3. Any change in the output voltage due to line or load change produces an "error" voltage across the control windings. This voltage causes a current flow which changes the firing point of the magnetic amplifiers, thus correcting for the change in output. The degree of correction, and hence the regulation accuracy, is determined by the gain of the magentic amplifier core, the windings, and the regulation accuracy of the "power reference".

1. Reference Source--The silicon diode, CR1, is operated in its zener or reverse current region. Under this condition, a constant voltage will appear at the terminals of the diode as the current varies within certain limits. CR1 is one arm of a bridge circuit consisting of R6, R7, R10, R13, and RT1 arranged so that any change in the output voltage will cause a change in the emitter circuit of Q4 (see figure 3).

2. Amplifying Transistors - The signal between the base and emitter of the first transistor Q4 is amplified by transistors Q3 and Q2 and applied to the power transistor Q1.

3. Power Transistor--The Power Transistor Q1 regulates the output of the "Power reference" by the total voltage drop from the emitter to the collector. In order to reduce the power loss in this transistor, its total voltage supply, which is connected to the emitter, is the sum of the output of the Nobatron and a voltage from the auxiliary power supply. The auxiliary supply circuits consists of T5, CR4 and C4. This supply is connected to the input power line.

   Since the reference voltage (collector of Q3) is connected to the output of the Nobatron, in series with the control coil, the voltage drop from the reference to the output is less than a volt. Therefore, the total emitter to collector voltage is the total of this small coil drop plus the auxiliary power supply voltage (the voltage across C4).

4. Temperature Compensation--RT1 is a Negative Temperature Coefficient resistor which is used to counter balance the positive coefficient of the remainder of the circuit.

5. Line Compensation--Compensation for input line voltage changes is accomplished in the "power reference" by applying voltage from the auxiliary power supply to the emitter of Q4 through resistors R11 and R16.

V. MAINTENANCE AND REPAIR

Maintenance

During normal life these Nobatrons require no maintenance other than the care afforded similar electronic equipment.

1. Cleaning Air Filter--Since the life of the silicon rectifiers can be considerably reduced by restricting the air flow, it is recommended that the air filter be removed and cleaned at frequent intervals, depending on the location of the Nobatron and the amount of foreign matter in the air.

2. Blower motor Lubrication--The blower motor should be lubricated at least each 1000 hours of operation with SAE #10 (light) oil. Two oil cups are provided on the motor for this purpose.

   To oil the motor, it is necessary to remove the blower and motor assembly. This is a simple operation. Simply snap the blower retaining rod out of the notches in the blower housing and swing it out of the way. Then pull the assembly out of the Nobatron after disconnecting the blower line cord.

   In the event it becomes necessary to clean the blower housing, it will become necessary to remove the housing from the wheels and motor. To do this, set the whole assembly face down on a table with the discharge duct openings facing down. Grasp the two housings at the same time and twist them in the direction of the arrow marked "off". You will find that the housings will unlock from the motor and wheel assembly, allowing this assembly to stand on the motor air duct as its support. Slip the two housings carefully off of the blower wheels. These housings can readily be put in a dish-pan and cleaned inside and out. You will find very little grease on the blower wheels. These can be cleaned by brushing lightly. Be careful in handling this unit. Do not bend the wheels so they will not run true.

Spare Parts

All components used in these Nobatrons are of a good commercial grade and can be expected to give a reasonably long period of trouble-free service. As the age of the instrument increases, some components are likely to deteriorate; we therefore suggest that those items recommended as spares, on the Replacement Parts List be kept on hand.

In the event it becomes necessary to replace any part, we strongly suggest that the replacement part be of the same value as the original. Substitute parts should not be used unless we give assurance that the substitute will not impair the performance of the Nobatron.

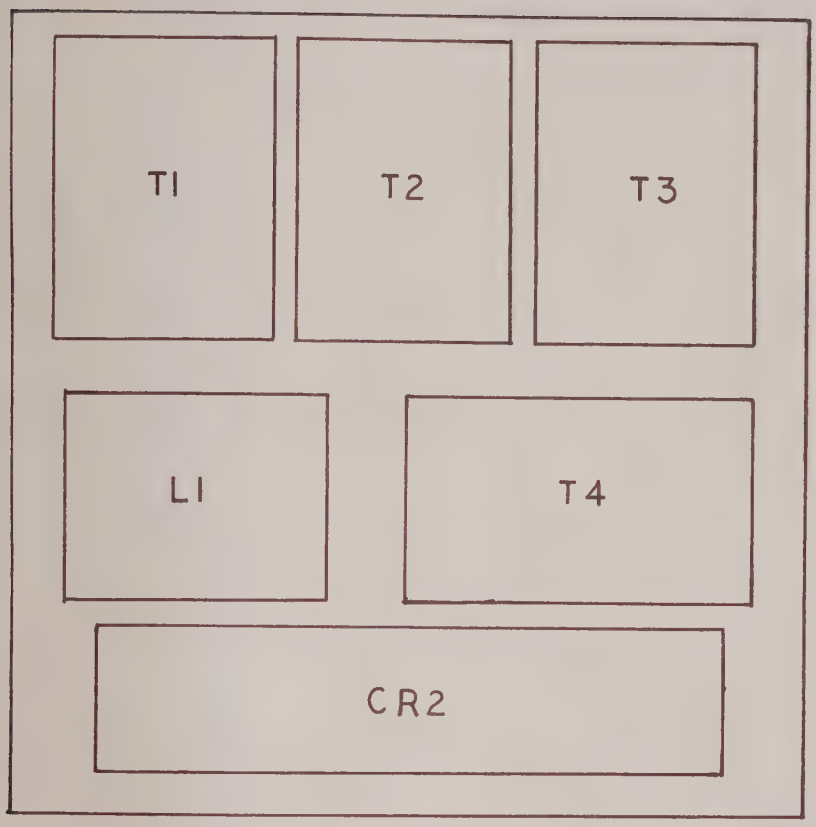
MAINTENANCE & REPAIR (CONT.)

Repair

CAUTION: DANGEROUS VOLTAGES EXIST IN THIS INSTRUMENT. BEFORE TOUCHING ANY INTERNAL PART, MAKE SURE THAT THE INPUT POWER HAS BEEN DISCONNECTED BY AN EXTERNAL SWITCH.

Trouble Shooting

Symptom	Likely Cause	Procedure for Repair
No Output Voltage	Circuit Breaker or Main Fuse Open	Replace fuse Reset Breaker
	Open Power or Filter Circuit	Check for Open Circuit in T1-3, T4, CR2, L1, and Ammeter Shunt
High Output Voltage	Power Reference Failure	Check Power Reference per schematic and test voltages. Typical causes of failure could be failure of Q1-4, CR1 open, Q1 shorted
Low Output Voltage	Open Fuse F1	Check Fuse F1
	Reduction of Blower Air	Blower not actuated by thermostats and relay.
	Power Reference Failure	Check Power Reference per schematic and test voltages. Typical cause of failure could be failure of CR1, Q1-4.
High Ripple	Filter Circuit Failure	Check input line balance and mag-amp balance, Check capacitors C1-3, L1.
Poor Regulation	Failure of CR1	Check or Replace CR1
	Line Comp. Failure	Check R11 & 16 for continuity.



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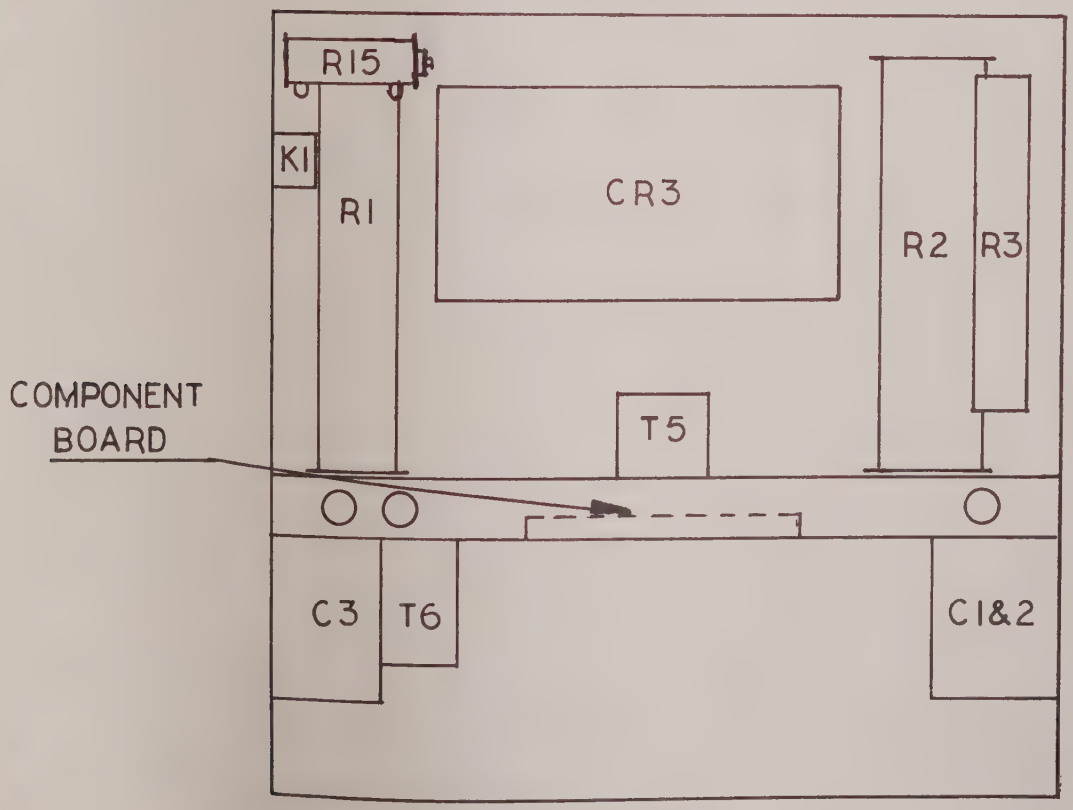
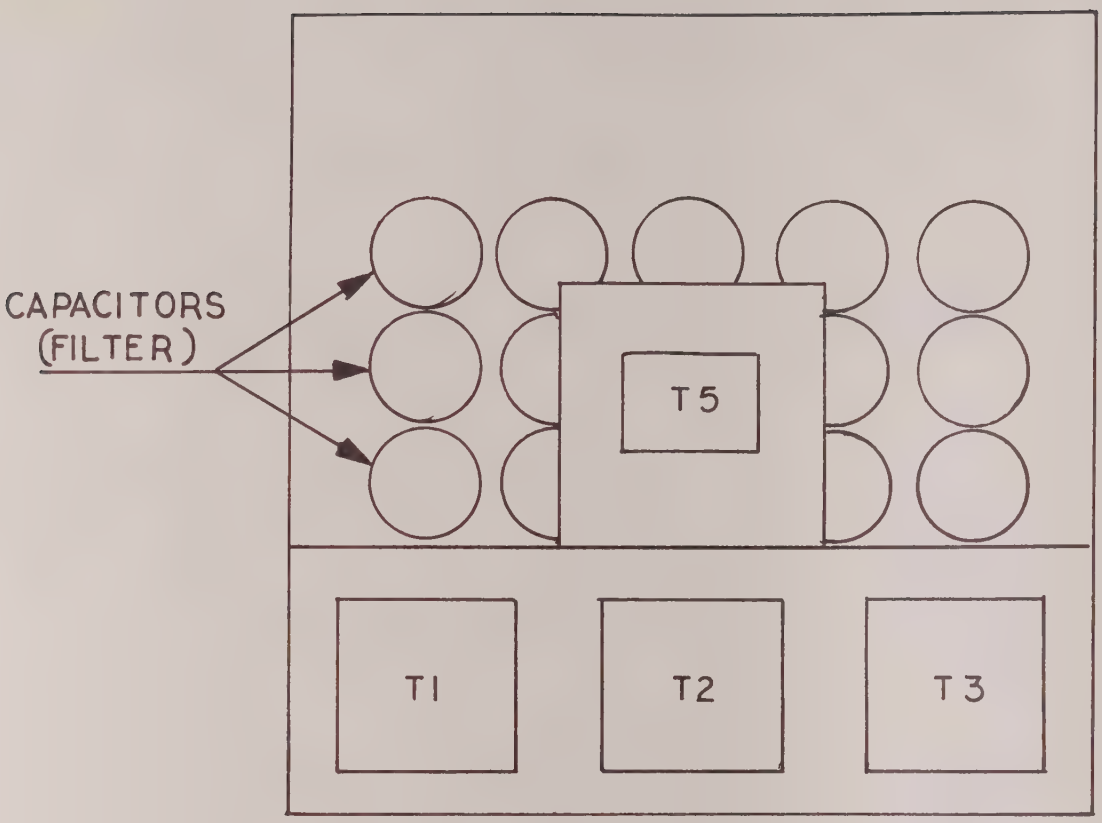


REAR

Model MA12-200 and Model MA28-125 Internal Views



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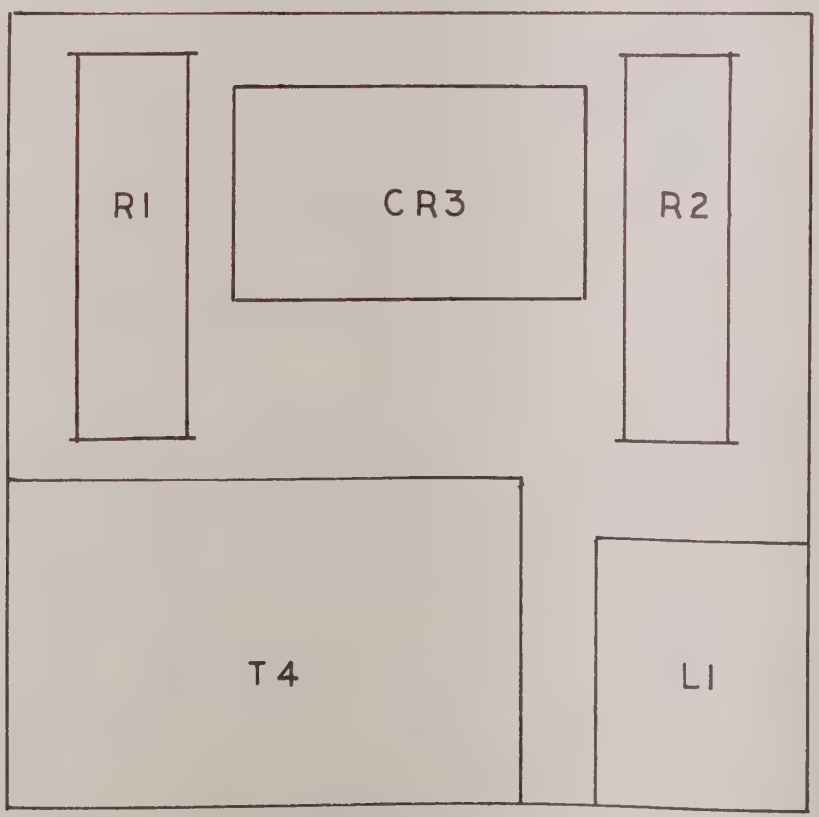
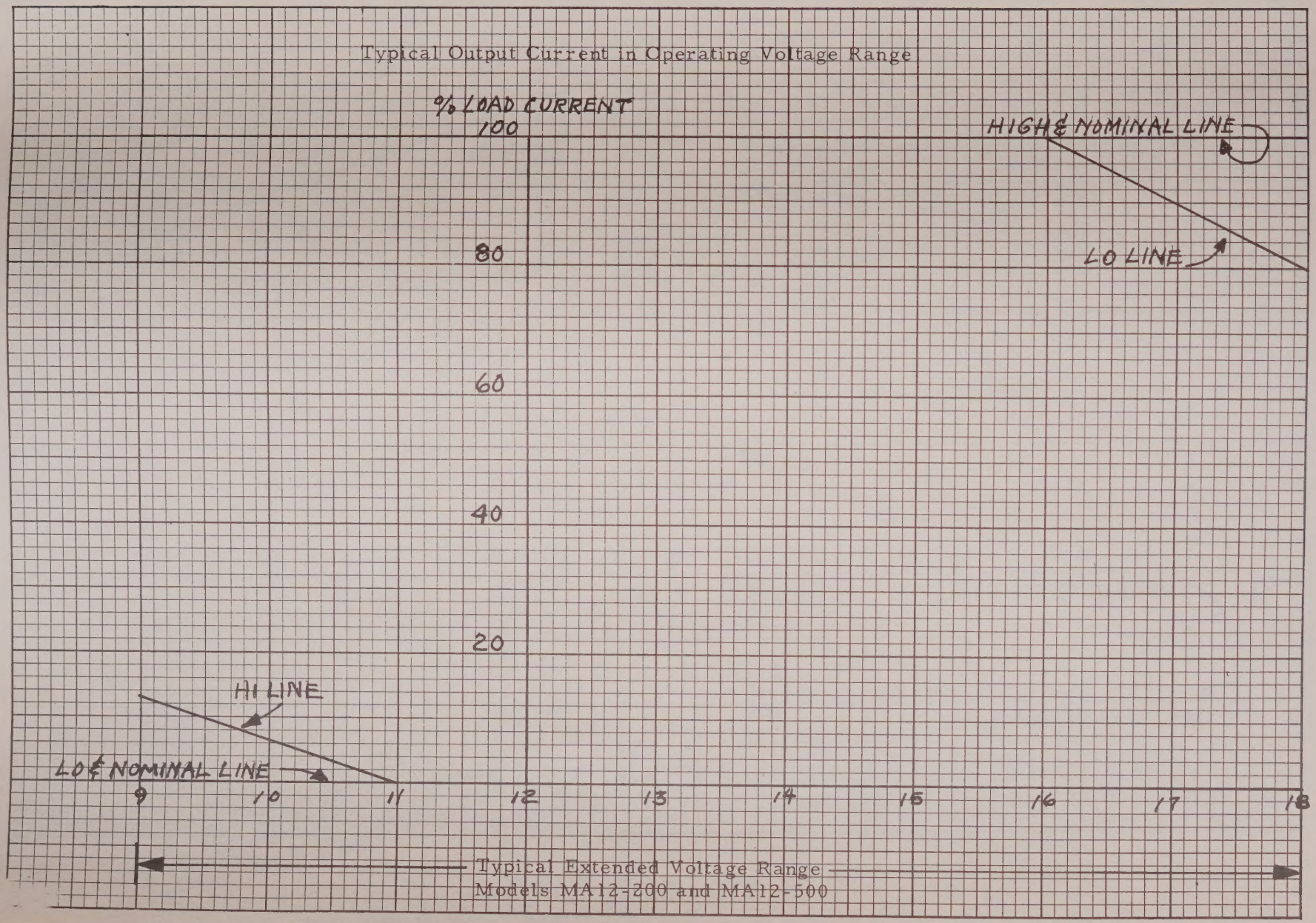


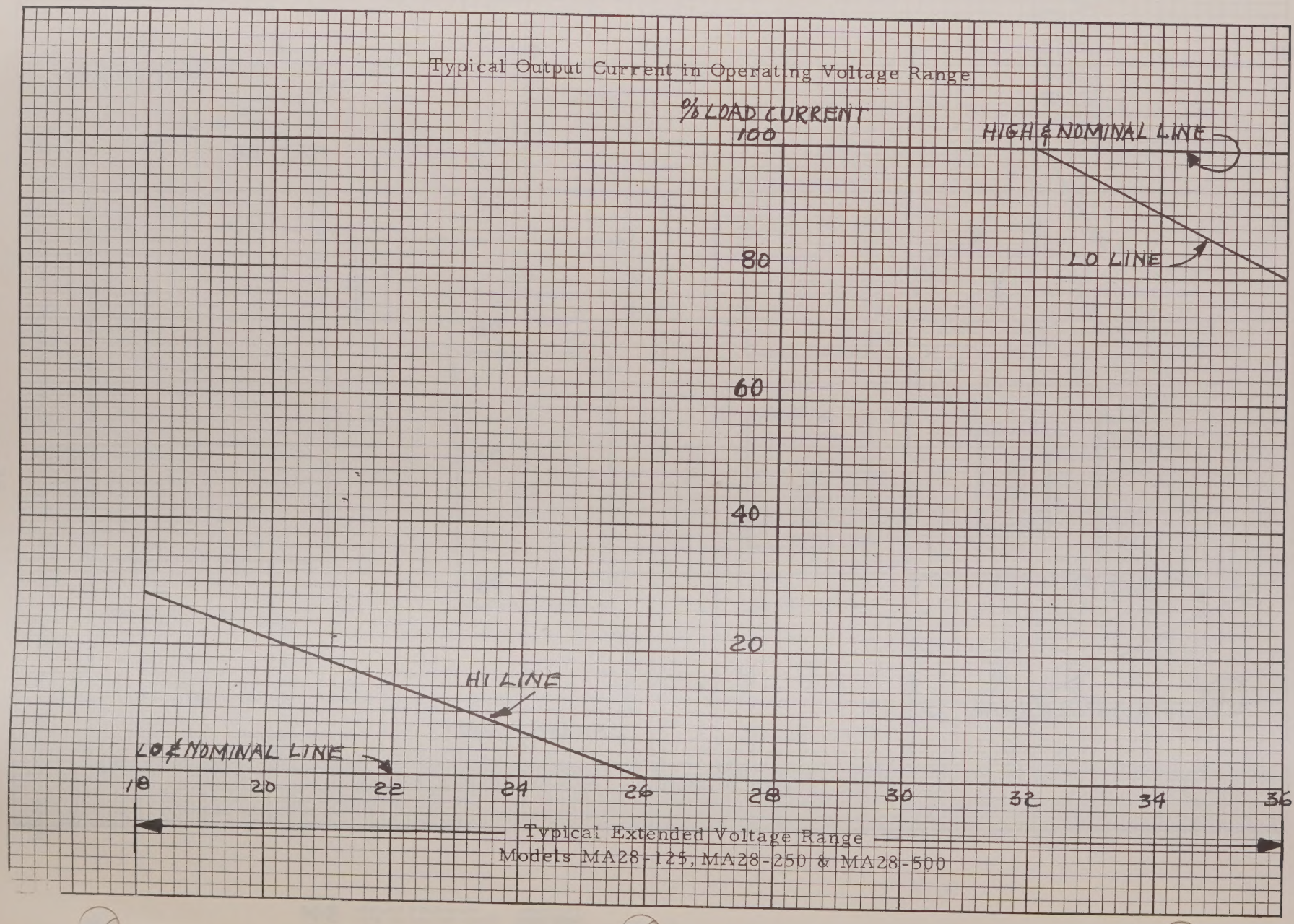
REAR

Model MA12-500, Model MA28-250 and Model MA28-50 Internal View

K+E 10 X 10 TO THE INCH 359-5DG
KEUFFEL & ESSER CO. MADE IN U.S.A.



K+E 10 X 10 TO THE INCH KEUFFEL & ESSER CO. 359-5DG MADE IN U. S. A.



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